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Mimicry of Scorpions by Juvenile Lizards, *Teratoscincus roborowskii* (Gekkonidae)

KELLAR AUTUMN[1] AND BATUR HAN[2]

[1]*Dept. of Environmental Studies, University of California, Santa Cruz, California, 95064, USA*
[2]*Urumqi Institute of Biology, Academia Sinica, Urumqi, Xinjiang Uygur Autonomous Region, China*

Abstract. -*Teratoscincus roborowskii* is a large nocturnal gecko that occurs only in the Turpan Depression of northwestern China. The striking similarity of dorsal coloration, escape behavior, and body size of juvenile *T. roborowskii* and a species of scorpion in the genus *Mesobuthus* (Bathidae) indicates probable Batesian mimicry by these lizards.

Key Words: Batesian mimicry, lizards, Gekkonidae, *Teratoscincus*, scorpions, China.

Introduction

Batesian mimicry is a well-documented phenomenon in both invertebrates and vertebrates (See Pough 1988a, 1988b for review of vertebrate mimicry). In the simplest case, three organisms are included in a Batesian mimetic relationship: 1) a noxious or potentially dangerous MODEL; 2) an edible and relatively harmless MIMIC; and 3) a potential predator of both model and mimic, the DUPE (Pasteur 1982, Pough 1988a, 1988b). Rejection of the model as a prey item confers an adaptive advantage to the dupe, which manifests itself in a learned or instinctive avoidance of the model. A superficial similarity to the model should be adaptive to other organisms preyed upon by the dupe; hence a mimetic relationship evolves (Bobisud and Potratz 1976, Turner 1988).

Mimicry in lizards is poorly documented and largely anecdotal (Pough 1988a, 1988b, 1989 pers. comm., Parker and Pianka 1974, Huey and Pianka 1977). Our account is anecdotal as well, and we hope that as more examples of lizard mimicry surface, solid scientific studies will follow.

We present a case of probable Batesian mimicry between juvenile *Teratoscincus roborowskii* (Gekkonidae) and a scorpion in the genus *Mesobuthus* (Bathidae). *Teratoscincus roborowskii* occurs only in the second lowest spot on Earth (-154 m.), the Turpan Depression, Xinjiang Uygur Autonomous Region, China (taxonomy after Macey et al. in prep). Sympatric with *T. roborowskii* is the scorpion, *Mesobuthus* sp. It was the superficial similarity between *Mesobuthus* sp. and juvenile *T. roborowskii*, and indeed our care in making a proper identification when collecting the lizards, that first suggested mimicry.

Methods

During the 1987 and 1988 cooperative Chengdu Institute of Biology, University of California, California Academy of Sciences herpetological expeditions to the deserts of western China, we observed and collected *Teratoscincus roborowskii* in the Turpan area. The study area was 4.4 km west of the Main Mosque in Turpan (42°58'N 89°10'E), on the Turpan-Jiaohe road, Turpan Prefecture, Xinjiang Uygur Autonomous Region, China. This area consists of a series of rocky hills with sparse vegetation -primarily *Alhagi sparsiflora* (Leguminosae). This was the same study area that was used by Autumn and Wang (1988). The scorpion, *Mesobuthus* sp., is common on the site and can be easily collected by turning rocks. The scorpion specimens were donated to the California Academy of Sciences. The lizard specimens were donated to the Museum of Vertebrate Zoology and to the California Academy of Sciences.

In order to compare *T. roborowskii* with the other *Teratoscincus* species, we

examined *T. przewalskii* from Dunhuang, Gansu Province, China, *T. bedriagai* from the Siesitan Basin, Iran, and *T. microlepis* and *T. scincus* from the Helmud Basin, Afghanistan. None of these species are sympatric with *T. roborowski*. These specimens were provided by the Museum of Vertebrate Zoology, and by the California Academy of Sciences.

Results

Teratoscincus roborowskii was extremely common on the study site. While holding a bright flashlight at shoulder height and turning in a full circle, we often observed over 40 eyeshines at a single spot. The geckos remain motionless on open ground, a short distance from their burrows. They seem to be solitary, and adults and juveniles were never observed together.

The similarity between juvenile *T. roborowskii* and *Mesobuthus* sp. is evident in the dorsal coloration, size, defensive posture, and escape behavior of the two animals:

1. Dorsal coloration.

Juvenile *T. roborowskii* are banded from head to tail (Fig. 1). These bands are dark, thin, and are only present on the dorsal surface. This banding is lost in the adult. The number of bands on the body ranges from 5 to 8, with a mode of 7. The number of bands on a non-regenerate tail ranges from 4 to 6, with a mode of 5. Similarly, *Mesobuthus* sp. has 7 plates on the body and 5 segments on the tail (excluding the stinger, which is folded back) [Fig. 2, Fig. 3]. When viewed under moonlight, the patterns of the two animals are extremely difficult to differentiate.

2. Size.

The mean snout-vent length of juvenile *T. roborowskii* is 42 mm (N = 43, SD = 4.1, range: 35-53 mm). The mean non-regenerate tail length is 27 mm. (N = 39, SD = 2.1, range: 23-37 mm). The mean total length is 69 mm. (N = 39, SD = 5.65, range: 58-90 mm.) The largest *Mesobuthus* sp. we collected had a body length of 30 mm and a tail length of 37 mm., for a total length of 67 mm.

3. Defensive posture.

When provoked (by humans), juvenile *T. roborowskii* stiffen the body and raise the tail in an arc. This is in contrast to the adults, which adopt an arched posture and wave the tail from side to side, producing hissing noise from the specialized caudal scales, as demonstrated by Werner (1967). The defensive posture of *Mesobuthus* sp. is typical of most scorpions. The legs and pedipalps are extended and the tail is held in an arc above the abdomen. This arc is similar in form to that seen in the juvenile *T. roborowskii*i

4. Escape behavior.

When approached, juvenile *T. roborowskii* scuttle quickly away -usually in a straight line- and stop a short distance away. The defensive posture mentioned above is usually maintained throughout flight. In contrast, adult *T. roborowskii* run for much longer distances, in a zig-zag pattern, and the body is thrown from side to side during flight. Both adults and juveniles will hide under *Alhagi sparsiflora* clumps or retreat into burrows if pursued. *Mesobuthus* sp. also run in approximately straight lines, for short distances.

The juvenile *T. scincus* we examined had 5 dorsal bands on the body and 5 thin dorsal bands on the tail. These specimens were the most similar in dorsal coloration to juvenile *T. roborowskii* and to *Mesobuthus* sp. The other *Teratoscincus* species specimens either had bands that were too broad or too few in number to accurately resemble scorpions. The juvenile *T.*

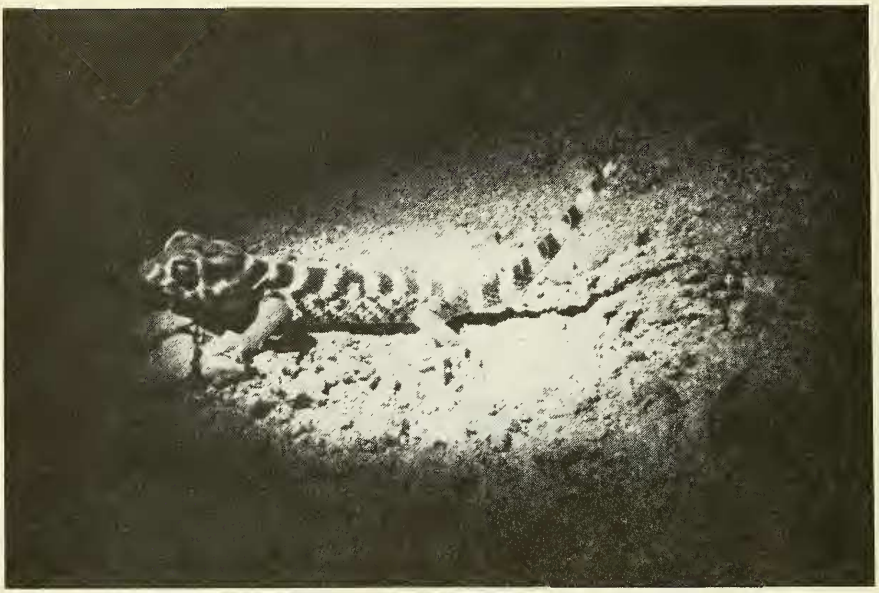

FIG. 1. Juvenile *Teratoscincus roborowskii* assuming a defensive posture while being photographed at night in the Turpan Depression, Xinjiang Uygur Autonomous Region, China, Sept. 10, 1988. This individual has 13 dorsal bands.

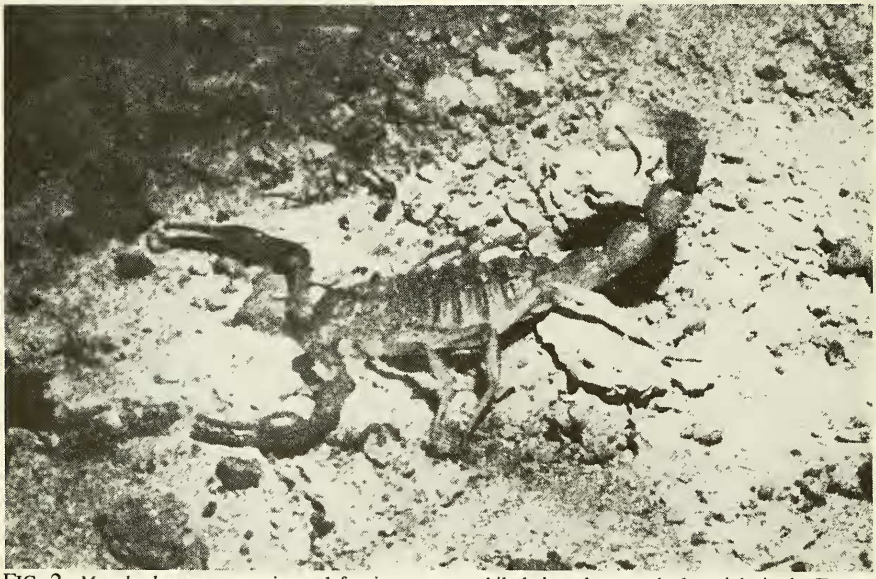

FIG. 2. *Mesobuthus* sp. assuming a defensive posture while being photographed at night in the Turpan Depression, Xinjiang Uygur Autonomous Region, China, Sep 10, 1988. This species has 13 obvious body and tail segments.

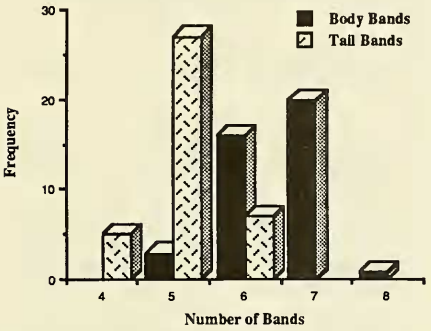

FIG. 3. Number of body and tail bands occurring in *Teratoscincus roborowskii* in the Turpan Basin. The mode of the body bands is 7 and the mode of the tail bands is 5. Similarly, the scorpion *Mesobuthus* sp., has 7 body segments and 5 tail segments.

przewalskii had 6-7 dorsal bands on the body and 2-4 broad dorsal bands on the tail. The juvenile *T. bedriagai* were unevenly banded on the body, and had 2 broad bands on the tail. Juvenile *T. microlepis* were mottled, with light bands on the body, and 7 light, uneven bands on the tail.

Discussion

Since tail-raising and arching is a common defensive behavior in other *Teratoscincus* (Mebs 1966), and other gekkonids as well (Bustard 1967, Johnson and Brodie 1974, Parker and Pianka 1974, Marcellini 1977, Vitt, et al 1977, Greene pers. comm., Huntley pers. comm), it may be an ancestral trait shared by most gekkonids, rather than a mimetic derivation in juvenile *Teratoscincus roborowskii*. Tail-raising and the possibly conspicuous tail-banding may misdirect the predator's attention to the readily autotomized tail (Pough 1988a, 1988b, Johnson and Brodie 1974, Parker and Pianka 1974, Vitt et al. 1977, Dial and Fitzpatrick 1981, Greene 1988 and Arnold 1988 for reviews).

However, 1) the behavioral differences of juvenile *T. roborowskii*, when compared with adults, 2) their similarity in dorsal coloration, size, defensive posture, and escape behavior to *Mesobuthus* sp., and 3) their relative availability to potential predators strongly indicates a mimetic relationship. Juvenile *T. roborowskii* differ greatly from other *Teratoscincus* juveniles in dorsal coloration. Only *T. roborowskii* and *T. scincus* possess thin dorsal bands that resemble scorpion segments. Furthermore, the kinematics of tail raising in juvenile *T. roborowskii* is not the same as that in *Coleonyx variegatus, C. brevis* (see Vitt, et al. 1977, p.328, and Dial and Fitzpatrick 1981 p.311 for figures), adult *T. roborowskii*. and adult *T. scincus* (Autumn, pers. obs., Mebs 1966 p. 17, 19 for figures). While juvenile *T. roborowskii* maintain a relatively rigid posture with the tail raised and parallel to the body, *Coleonyx* and adult *Teratoscincus* adopt an arched posture and wave the tail. It is plausible that the evolution of scorpion mimicry in juvenile *T. roborowskii* was made possible by the ancestral banding and postural characters.

Candidates for the dupe include the little owl, *Athene noctua* (de Schauensee 1984), the red fox, *Vulpes vulpes* (Tate 1947), the sand boa, *Eryx tatarticus*, and adult *Teratoscincus roborowskii*. Macey and Papenfuss (1986 pers. comm) reported that several adult *T. roborowskii* had regurgitated undigested juvenile *T. roborowskii* while in a sack. Adults and juveniles were kept together and it is likely that predation took place in the sack.

Juvenile *T. roborowskii* may not able to function as mimics throughout their activity period. Unless the mimicry is tactile as well, the similarity should only be present while the lizards are out of their burrows and are in sufficient light, as is present during moonlit hours. However, the selective advantage should still be substantial if moonlight provides the greatest mimetic protection during a period when predation pressure by visual predators is likely to be the highest.

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